Teacher Guide for Laboratory Sciences

Biology

Chemistry

Physics

Second-year Integrated/Coordinated Science

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2003

Golden State Examination

GSE

CALIFORNIA DEPARTMENT OF EDUCATION

This document has been prepared by the Sacramento County Office of Education and San Joaquin County Office of Education, under contract with the California Department of Education. For information about the Golden State Examination testing dates, registration materials and procedures, or the Golden State Seal Merit Diploma, contact:

Standards and Assessment Division
California Department of Education
1430 N Street, Suite 5408
Sacramento, CA 95814

Mailing Address: P.O. Box 944272, Sacramento, CA 94244-2720

Telephone: (916) 445-8765 Fax: (916) 319-0969

E-mail: star@cde.ca.gov

Web site:

http://www.cde.ca.gov/statetests

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Brian Criner
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David Darwazeh
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San Joaquin County

Susan Emerson
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Cheryl Gabler
Grossmont Union High
San Diego County

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California State University,
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In addition, we thank California teachers who contributed additional test questions through participation in GSE item-writing workshops.

Table of Contents

Introduction

Using the Golden State Examination Teacher Guide

The *Golden State Examination Teacher Guide* has been developed to provide essential information and preparation guidelines for teachers and to serve as an instructional aid in the classroom. The guide is divided into the following sections:

Test Content — outlines state content standards for which Golden State Examination (GSE) questions are developed.

Test Structure — describes the format of the test.

Scoring Guide — outlines the standards-based criteria used to score laboratory task responses.

Sample Questions — includes sample questions that represent types of questions found on the exams.

Teachers are encouraged to reproduce portions or all of the guide for classroom use. Districts/schools also may use these materials with state standards for staff development.

Student Eligibility

The Golden State Examinations in Biology, Chemistry, Physics, and Second-year Integrated/Coordinated Science are given during the spring test administration. Each examination may be taken only once.

These are end-of-course exams. Students who are enrolled in the course at the time the examinations are given and students who have taken the course since the last test administration may take the exams.

Test Preparation

The Golden State Examinations in laboratory sciences are aligned to state content standards. Teachers should review their curriculum and instructional activities for alignment to these standards.

Sound preparation for the Golden State Examinations should include classroom assignments that allow students to articulate the major ideas and concepts in the subject area being tested. Students also must be able to analyze information, apply knowledge, solve problems, and organize evidence to explain findings from laboratory experiments.

Note: It also is important that students and parents receive information about the testing dates and ways to prepare for the exams well in advance.

Special Accommodations

Accommodations for testing as specified in a student's Individualized Education Program (IEP) or 504 plan apply to GSE administration. For students with visual impairments, a copy of the examination to be administered can be sent to the district for enlargement or reproduction in braille. Please allow sufficient time for this process. Contact NCS Pearson, the GSE testing contractor, at (800) 627-7990 ext. 805 for more information, questions, and/or arrangements for special testing needs or situations.

Reporting Results

Currently, the Golden State Examinations in Biology, Chemistry, Physics, and Second-year Integrated/Coordinated Science each consist of two 45-minute sessions. Students who complete both sessions receive an individual report of results. Scores for the multiple-choice and written-response portions of the exam are combined to produce the student's overall achievement level. There are six achievement levels: high honors (6), honors (5), recognition (4), and acknowledgment for participation (3, 2, and 1). Results of the spring administration are mailed to districts in October.

Resource Documents

The *Science Content Standards for California Public Schools, Kindergarten Through Grade Twelve,* and the curriculum frameworks are available at the California Department of Education, CDE Press, Sales Office, P.O. Box 271, Sacramento, CA 95812-0271; 1-800-995-4099 ext. 6. These documents also are available at http://www.cde.ca.gov/board on the Internet.

Other Resources

Testing schedules and other information are available from your district GSE coordinator, your county office of education, or the California Department of Education at http://www.cde.ca.gov/statetests/gse on the Internet.

Test Content for Biology, Chemistry, Physics, and Second-year Integrated/Coordinated Science

The content of the Golden State Examinations in Biology, Chemistry, Physics, and Second-year Integrated/Coordinated Science is aligned to the science content standards, grades nine through twelve. The *Science Content Standards for California Public Schools, Kindergarten Through Grade Twelve*, and curriculum frameworks are available at http://www.cde.ca.gov/board on the Internet.

The examinations emphasize the understanding of fundamental scientific concepts and ideas that form the foundation of each content area. Students also must demonstrate analytical, experimentation, and investigation skills.

Questions are aligned to the state science content standards, including asterisked standards.

Biology

- Cell Biology (1a–j)
- Genetics (2a–g; 3a–d; 4a–f; 5a–e)
- Ecology (6a–g)
- Evolution (7a–f; 8a–g)
- Physiology (9a–I; 10a–f)

Chemistry

- Atomic and Molecular Structure (1a–j)
- Chemical Bonds (2a–h)
- Conservation of Matter and Stoichiometry (3a–g)
- Gases and Their Properties (4a–i)
- Acids and Bases (5a–g)
- Solutions (6a–f)
- Chemical Thermodynamics (7a–f)
- Reaction Rates (8a–d)
- Chemical Equilibrium (9a–c)
- Organic Chemistry and Biochemistry (10 a–f)
- Nuclear Processes (11a–g)

Physics

- Motion and Forces (1a–m)
- Conservation of Energy and Momentum (2a–h)
- Heat and Thermodynamics (3a–g)
- Waves (4a–f)
- Electric and Magnetic Phenomena (5a–o)

Second-year Integrated/ Coordinated Science

Content standards include those listed for Biology, Chemistry, and Physics and the following Earth Science standards:

- Earth's Place in the Universe (1a–g; 2a–g)
- Dynamic Earth Processes (3a–f)
- Energy in the Earth System (4a–d; 5a–g; 6a–d)

For All Sciences

- Investigation and Experimentation (1a–n)

Test Structure for Biology, Chemistry, Physics, and Second-year Integrated/Coordinated Science

The Golden State Examinations in Biology, Chemistry, Physics, and Second-year Integrated/Coordinated Science are currently two-part examinations, administered in 45-minute sessions.

Session one consists of multiple-choice questions. The questions are designed to cover the breadth of the subject area and may be linked to scenarios, diagrams, illustrations, or data tables.

The multiple-choice portion of the examinations is machine scored. Sample multiple-choice questions and answer keys are on pages 10–11 for biology, pages 18 –19 for chemistry, pages 26–27 for physics, and pages 35–36 for second-year integrated/coordinated science.

Session two consists of a laboratory experiment and related interpretation and application questions. The laboratory task is performed independently by each student at individual laboratory stations. Only one laboratory task in each subject area is administered to all students in a particular year. Different tasks will be used in subsequent years. The laboratory tasks require students to use laboratory equipment and chemicals under supervised and safe conditions.

Students should be prepared to:

- show an understanding of appropriate laboratory procedures
- document observations and data in an accurate and detailed manner
- support all analyses, calculations, and conclusions with specific evidence
- use scientific arguments to demonstrate their knowledge of scientific methods, concepts, and principles and their application to real-life situations

Sample laboratory tasks are on pages 12 –17 for biology, pages 20–25 for chemistry, pages 28 –33 for physics, and pages 37– 42 for second-year integrated/coordinated science.

The laboratory tasks are scored by experienced science teachers and other professionals in the field.

Teachers are encouraged to duplicate this guide for student use and to have students test themselves with the sample questions and laboratory tasks. State content standards addressed by each laboratory task are identified for the purpose of this guide but do not appear on the examination.

Preparing for Administration of Laboratory Tasks

Each student performs the laboratory task individually using laboratory materials and equipment set up at testing stations before the test administration. The General Instructions for the Session Two Laboratory Task and Teacher/Proctor Instructions provided in the *Administration Manual for Laboratory Sciences* include information, instructions for station setup, and a list of materials to be provided by the school (e.g., waste containers, goggles, paper towels). Most laboratory materials are provided in individual lab kits that arrive several days prior to test administration. Please note that some tasks require that materials be prepared at least one day before test administration.

For a class of 30 students, a teacher needs to set up 30 stations. Students may be tested in multiple sessions. Therefore, the teacher needs to check each testing station, verify that all required materials are present, and replenish any materials that have been used up or broken before the next class enters the room. Physical visual barriers must be constructed and set up between the testing stations. The room in which the exams are administered should have any scientific charts removed or covered.

It is recommended that there be at least one additional person, such as a responsible student aide, parent assistant, or another teacher, in the testing room to assist in administration of the laboratory task and collection of test materials. Help is needed to pass out materials, collect waste, replenish materials, and check stations.

Calculators may be used for the 2003 administration. Beginning with the 2004 administration, calculators may not be used.

Golden State Examinations—California Standards Tests

Education Code section 60650 now requires Golden State Examinations (GSE) to be administered as an augmentation to the California Standards Tests (CST) unless there is no CST in the subject area being tested. *Education Code section 60653* requires the GSE to consist of some portion of the CST and additional GSE items in order to reduce testing time in subjects for which a GSE and a CST exist.

It is anticipated that the GSE in Biology and the GSE in Chemistry will be administered as augmentations to the CSTs in 2004. Information about the format of the exams will be included in the 2004 teacher guide.

It is anticipated that the GSE in Physics and the GSE in Second-year Integrated/Coordinated Science will be administered as augmentations to the CSTs in 2005.

Scoring Guides for Laboratory Tasks

The laboratory task portion of the Golden State Examinations in Biology, Chemistry, Physics, and Second-year Integrated/Coordinated Science is scored in four components: Experimentation Skills, Conceptual Understanding, Analysis and Interpretation, and Application and Extension. The general scoring guides for the four components are given below.

Component I
Experimentation Skills

Score Point 3

The student response demonstrates thorough use of experimentation skills. The response:

- demonstrates accurate use and manipulation of appropriate equipment
- presents accurate and appropriate observations with detail
- displays accurate data appropriately in tables, charts, and/or graphs
- may include a few errors or omissions that detract little from understanding

Score Point 2

The student response demonstrates basic experimentation skills. The response:

- demonstrates use and manipulation of equipment
- presents observations; some may not be accurate, complete, or appropriate
- displays data in tables, charts, and/or graphs
- may include some errors or omissions that may detract from understanding

Score Point 1

The student response demonstrates little or no use of experimentation skills. The response:

- demonstrates an attempt to use and manipulate equipment
- presents observations that are incomplete, inaccurate, or inappropriate
- displays incomplete or inaccurate data in tables, charts, and/or graphs
- may include substantial errors or omissions that detract from understanding

Component II
Conceptual Understanding

Score Point 4

The student response demonstrates thorough understanding of scientific concepts related to the task. The response:

- includes correct and appropriate explanations and/or discussions of scientific concepts
- demonstrates use of accurate terminology to clearly and effectively communicate scientific understanding
- may include minor errors that do not detract from understanding

Score Point 3

The student response demonstrates general understanding of scientific concepts related to the task. The response:

- includes general explanations and/or discussions of scientific concepts
- demonstrates use of mostly accurate terminology to communicate scientific understanding
- may include a few errors or omissions that detract little from understanding

Score Point 2

The student response demonstrates partial understanding of scientific concepts related to the task. The response:

- includes partial explanations and/or discussions of scientific concepts
- demonstrates use of terminology that may hinder communication of scientific understanding
- may include several errors, omissions, or misconceptions that may detract from understanding

Score Point 1

The student response demonstrates little or no understanding of scientific concepts related to the task. The response:

- includes an attempt to explain and/or discuss scientific concepts; may be incomplete, incorrect, or mostly off-topic
- demonstrates use of inappropriate/ineffective terminology that hinders communication of scientific understanding
- may include substantial errors, omissions, or misconceptions that detract from understanding

Component III
Analysis and Interpretation

Score Point 4

The student response demonstrates thorough use of the information derived from the laboratory task, together with related scientific concepts, to analyze, solve problems, and interpret laboratory findings. The response:

- demonstrates a high level of reasoning in formulating explanations and predictions that are clearly and logically supported by evidence from the task
- relates variables accurately and, when needed, shows appropriate mathematical calculations
- includes accurate and appropriate interpretations of graphs and data
- includes accurate and appropriate identification of possible reasons for inconsistent results
- may include minor errors that do not detract from understanding

Score Point 3

The student response demonstrates general use of the information derived from the laboratory task, together with related scientific concepts, to analyze, solve problems, and interpret laboratory findings. The response:

- demonstrates sound reasoning in formulating explanations and predictions that are supported but may lack some detail

- relates variables and, when needed, shows mathematical calculations
- includes appropriate interpretations of graphs and data
- includes appropriate identification of possible reasons for inconsistent results
- may include a few errors or omissions that detract little from understanding

Score Point 2

The student response demonstrates partial use of the information derived from the laboratory task, together with related scientific concepts, to analyze, solve problems, and interpret laboratory findings. The response:

- contains explanations that are partial, may not be clearly supported, or may be flawed
- relates some variables and, when needed, may show some mathematical calculations
- includes interpretations of graphs and data; reasoning may be flawed
- includes identification of some possible reasons for inconsistent results; reasoning may be flawed
- may include several errors, omissions, or misconceptions that may detract from understanding

Score Point 1

The student response demonstrates little or no use of the information derived from the laboratory task, together with related scientific concepts, to analyze, solve problems, and interpret laboratory findings. The response:

- contains explanations that are incomplete, incorrect, or mostly off-topic
- shows an attempt to relate variables and, when needed, to show mathematical calculations; may be highly flawed
- includes an attempt to interpret graphs and data; reasoning may be highly flawed
- includes identification of possible reasons for inconsistent results; reasons may be incomplete, incorrect, or mostly off-topic
- may include substantial errors, omissions, or misconceptions that detract from understanding

Component IV
Application and Extension

Score Point 3

The student response shows thorough understanding of scientific concepts in applying and extending the information from the laboratory task. The response:

- shows effective, logical, and appropriate application of scientific concepts to a given situation and/or connects ideas to scientific concepts outside the laboratory task
- demonstrates a high level of reasoning in the analysis of situations and problem solving that requires combining, applying, and/or synthesizing information
- includes clear explanations of the findings
- may include minor errors or omissions that do not detract from understanding

Score Point 2

The student response shows basic understanding of scientific concepts in applying and extending the information from the laboratory task. The response:

- shows application of scientific concepts to a given situation and/or connects ideas to scientific concepts outside the laboratory task
- demonstrates some reasoning in the analysis of situations and problem solving that requires combining, applying, or/or synthesizing information
- includes partial explanations of the findings
- may include some errors, omissions, or misconceptions that may detract from understanding

Score Point 1

The student response shows little or no understanding of scientific concepts in applying and extending the information from the laboratory task. The response:

- shows an attempt to apply scientific concepts to a given situation and/or connect ideas to scientific concepts outside the laboratory task
- demonstrates an attempt at explaining and problem solving that requires combining, applying, and/or synthesizing information
- includes explanations that are incomplete, incorrect, or mostly off-topic
- may include substantial errors, omissions, or misconceptions that detract from understanding

Sample Multiple-choice Questions for Biology

Use the information provided in the table to answer question 1.

Test Tube	Contents of Test Tube	Initial Color of Solution in Test Tube	Color after 30 minutes
1	• water	clear	clear
2	• water • 4 drops indicator	blue	blue
3	• water • 4 drops indicator • acid	blue	yellow
4	• water • 4 drops indicator • base	blue	red
5	• water • 4 drops indicator • Organism X	blue	yellow

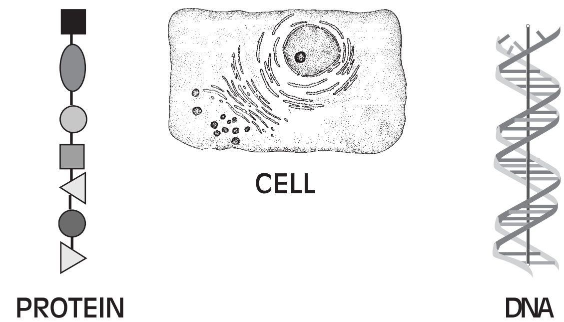
1. What could you conclude from this experiment given only the indicated information?

   A. Organism X produced a substance that resulted in a pH greater than 7.

   B. Organism X produced a substance that resulted in a pH lower than 7.

   C. Organism X is a plant.

   D. Organism X is an animal.

2. 

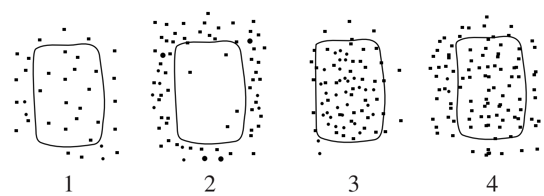
   What is the relationship between the three structures in the diagram above?

   A. DNA is produced by protein which is produced in the cell.

   B. Protein is composed of DNA which is produced in the cell.

   C. DNA controls the production of protein in the cell.

   D. A cell is composed only of DNA and protein.

3. 

   The diagram above shows four cells immediately after they were placed in solutions with different concentrations of glucose (small) molecules. The dots in the diagram represent glucose molecules.

   In which of the cells will there be a net loss of water?

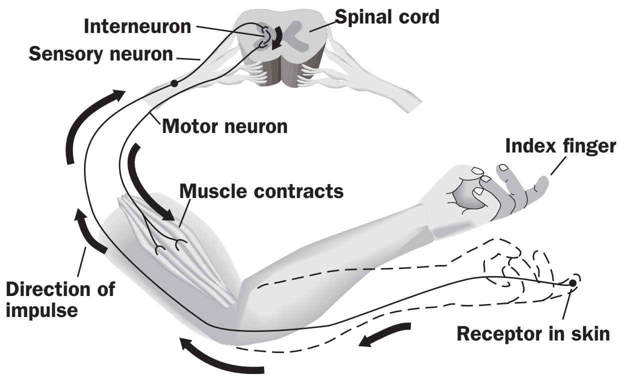
   A. 2 only

   B. 1 and 2

   C. 3 only

   D. 3 and 4

4. **Use the following diagram to answer the question.**



When an index finger is hit by a small hammer, an advantage of the reflex arc is that nerve impulses

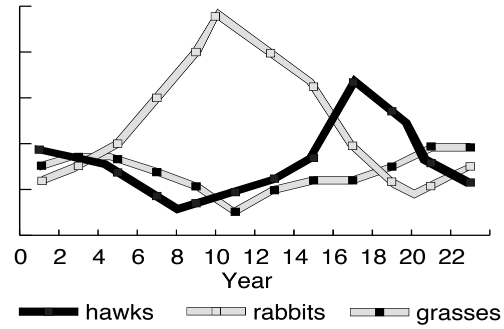
A. do not need to travel to the brain first.

B. travel quickly to the brain.

C. travel faster across nerve-end gaps.

D. activate sensory organs.

Use the following graph to answer questions 5 and 6.



5. The graph above shows the changes in the population sizes of grasses, rabbits, and hawks living in an ecosystem over a 22-year period.

   Which is a possible explanation for changes in the rabbit population between year four and year ten?

   A. an increase in the number of competitors

   B. a decrease in food availability

   C. a decrease in the hawk population

   D. destruction of the rabbits' habitat

6. If a disease destroyed the hawk population during year 22, the grass population would **MOST** likely ____________ over the next 5–6 years.

   A. increase

   B. decrease

   C. remain steady

   D. become extinct

Biology Answer Key

1. B	4. A
2. C	5. C
3. A	6. B

Sample Laboratory Task for Biology

Title: Rice Blight

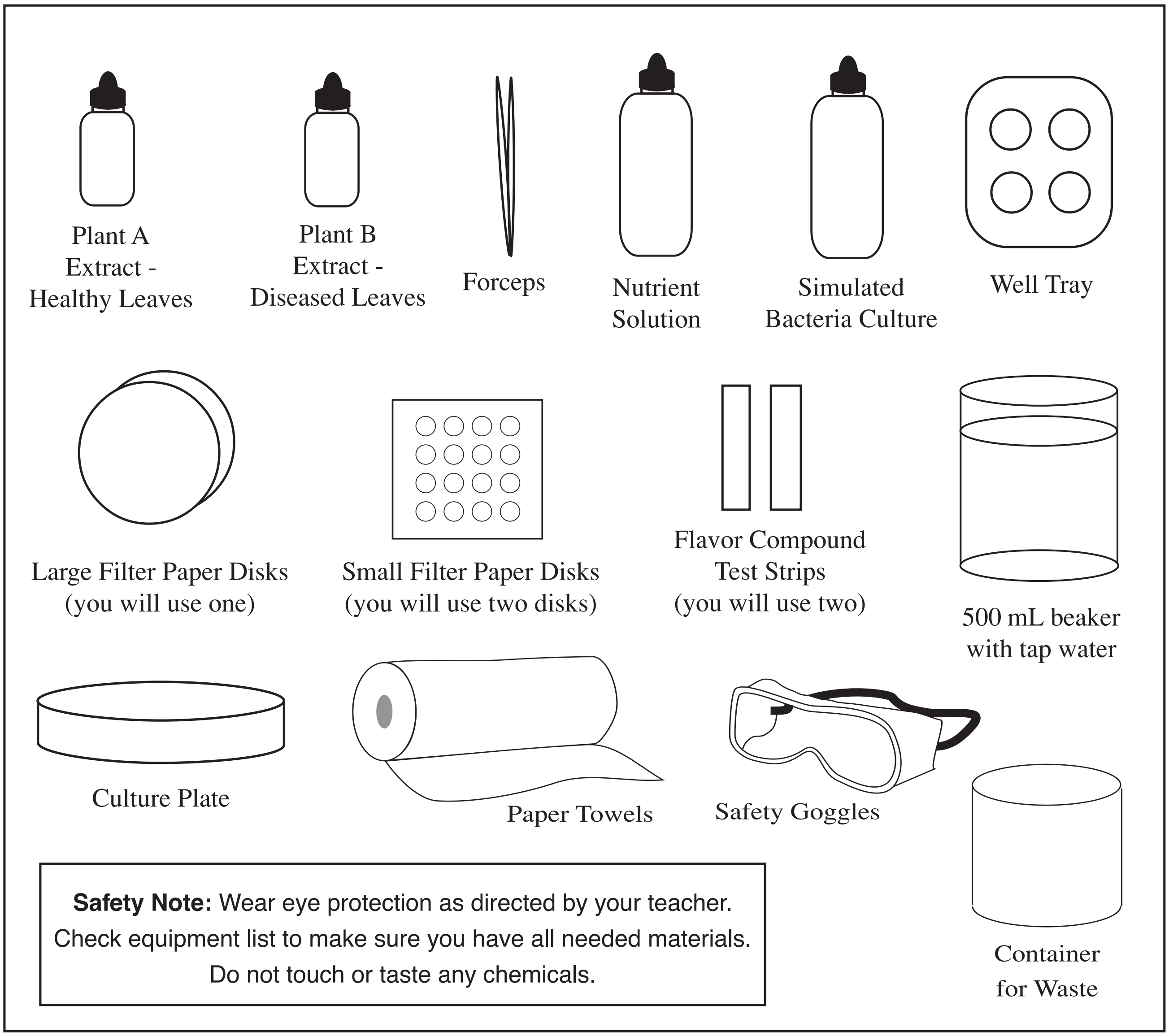
Investigation and Experimentation Standards – 1a,c,d,g,i,j,k,l,m

Genetics Standards – 2c,d,e,g, and 3a,b; Ecology Standard – 6b; Evolution Standards – 7a,c,d, and 8a

Materials

On the table you will find each of the following:

Station Setup



Safety Note: Wear eye protection as directed by your teacher. Check equipment list to make sure you have all needed materials. Do not touch or taste any chemicals.

Directions

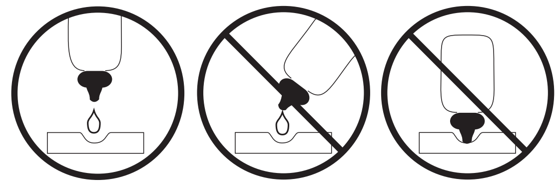
These instructions will not be repeated during the procedures.

Read and follow all the steps of this lab in the order given.

Record all observations, results, and answers to the questions as directed.

Immediately notify the proctor of spills or other problems.

When adding test solutions in the next sections, hold the bottles as illustrated in the diagrams.



Hold the bottles upright.
Do not contaminate stock solutions.

Statement of the Task

Every year, thousands of acres of crops that humans grow for food are lost to disease. Bacteria that cause many of these diseases can cause damage to the leaves or roots of these plants or can kill the entire plant.

Farmers in Golden County have many ways to reduce the damage to their plants caused by disease. One way is the use of chemical pesticides that kill bacteria. While chemical pesticides are very effective against bacteria, over time bacteria may develop a genetic resistance to the pesticides. Another way is to breed plants that are resistant to the disease. Over time, plants can also develop their own genetic resistance to the bacteria that cause disease.

In this task you will collect and examine data to determine the characteristics of rice plants. You will make recommendations on how farmers may get a healthy crop of rice with the special flavor people want. The investigation will include:

- examining disease resistance in rice plants
- determining genetic relationships in rice plants
- testing for flavor compound in rice plants

Note:
No actual bacteria are used in this lab task. You will use chemicals that react to give the same results that real bacteria would give. The chemicals are very safe, very dilute, and commonly used in science classrooms.

Disease Resistance in Rice

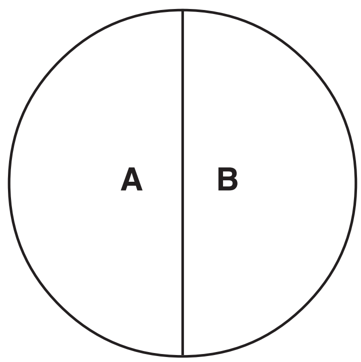
Most bacteria in the rice fields of Golden County are not killed by pesticides. Among the diseased and dying rice plants, the farmers sometimes find a few healthy rice plants that the bacteria do not seem to harm.

Some plants produce substances that help them resist diseases caused by the bacteria. To test for this substance, you will use a culture plate with simulated bacteria.

1. Preparing Simulated Bacteria Culture Plate

   Simulated bacteria that cause disease in rice plants can be grown on a large filter paper disk that is placed in the center of a culture plate. You will soak the disk with a nutrient solution to help the bacteria grow.

   a. Using your pencil or pen, draw one line down the center of the **large** filter paper disk. Label sides A and B as shown below.



   b. Place the large filter paper disk in the bottom of the culture plate.

   c. Place about 20-30 drops of the nutrient solution on the large filter paper disk so that all of the filter paper is wet.

   d. Place about 20-30 drops of the simulated bacteria culture on the large filter paper disk so that all of the filter paper is hot pink or purple in color.

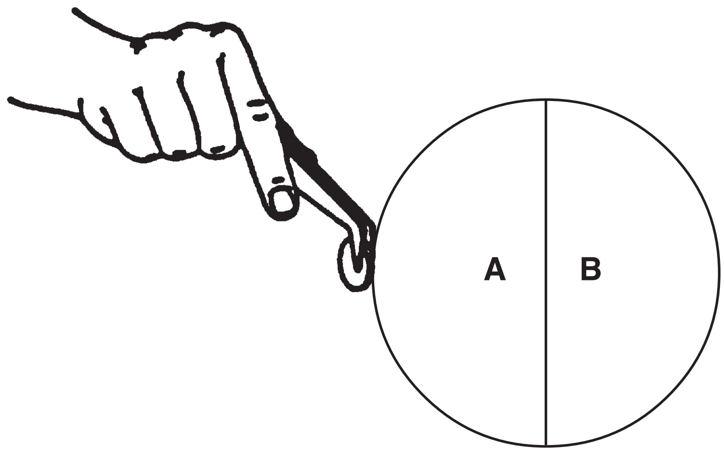
2. Testing Rice Plants

   Rice plant extracts have been prepared by grinding up leaves and mixing them in water. Plant A Extract is from a plant with healthy leaves and Plant B Extract is from a plant with leaves that appear damaged by bacteria (diseased leaves). You will test each plant to see if it contains a chemical that kills the simulated bacteria growing on the culture plate you just prepared.

   a. Place 4-5 drops of **Plant A Extract — Healthy Leaves** into well #1.

   b. With the forceps provided, soak one **small** filter paper disk in **Plant A Extract — Healthy Leaves** contained in well #1.

c. Place the disk soaked in **Plant A Extract — Healthy Leaves** in the center of side A on the culture plate. Use a paper towel to dry off the forceps.



d. Place 4-5 drops of **Plant B Extract — Diseased Leaves** into well #2.

e. Repeat steps b and c for **Plant B Extract — Diseased Leaves** and place the disk in the center of side B on the culture plate.

f. Observe the disks and the areas surrounding them. The purple or hot pink area represents the simulated bacteria. A white area surrounding the disk is called a zone of inhibition. This zone of inhibition indicates that the chemical in the plant extract has killed the simulated bacteria.

g. Record your observations in Table 1 below.

Table 1: Simulated Bacteria Resistance in Rice

	Observations
Plant A Extract - Healthy Leaves	
Plant B Extract - Diseased Leaves	

3. Using your knowledge of biology, explain how plant populations can acquire a trait such as disease resistance.

Genetic Relationships in Rice Plants

Some farmers have crossed plants that are resistant to the bacteria with those that are not. After crossing the plants, they counted the number of offspring that had resistance to the bacteria (healthy) and those that did not (diseased/dying). Their results are shown below.

		Cross	
Parent plants (P)	Resistant to disease	X	Not resistant to disease

	Number of plants resistant to disease (healthy)	Number of plants not resistant to disease (diseased/dying)
First generation (F_1):	0	987

4. The farmers were disappointed with the results of the cross. Use your understanding of genetics to provide a possible explanation for these results.

A child of one of the farmers had been learning about genetics in biology class and suggested that it was important to continue the experiment by crossing the offspring (F_1) plants with each other. The results are shown below.

		Cross	
Offspring (F_1)	Not resistant to disease	X	Not resistant to disease

	Number of plants resistant to disease (healthy)	Number of plants not resistant to disease (diseased/dying)
Second generation (F_2):	237	760

5. Use your understanding of genetics to explain these results.

6. Describe a process the farmers might use to obtain a crop of rice that is entirely resistant to disease. Explain why this process would be successful.

Flavor Compound in Rice Plants

The rice grown in Golden County has a special flavor because of the presence of a particular chemical compound. Consumers, however, have complained that the rice from the disease-resistant new crops does not have the special flavor. Some farmers suspect that the plants that are resistant to the bacteria might not have the compound. To test the plants for the presence of the compound, do the following:

7. a. Using a flavor test strip, **Plant A Extract**, and an unused well, design and carry out a test for the flavor compound in **Plant A Extract.**
   b. Record your data in Table 2 below.
   c. Repeat steps a and b for **Plant B Extract.**

Table 2: Flavor Compound

	Test strip color	Flavor compound
Control	Blue	Present
Plant A - Healthy Leaves		
Plant B - Diseased Leaves		

8. Based on the results of all of your investigations (the Disease Resistance test and Genetic Relationships) and the data provided from the flavor compound test, recommend to the farmers how they can get a healthy crop of rice with the special flavor people want.

Using the knowledge gained from this lab task and your own knowledge of science, answer the question below. Make your answer detailed and complete.

9. A field where the new disease-resistant rice plants were growing was abandoned. Over the next 25 years, the rice plants have continued to grow among the native plants in the surrounding environment. Describe the possible effects the rice plants might have on the living and nonliving parts of the ecosystem (e.g., plants, animals, microorganisms, non-living components) over the 25-year period. Your discussion may include, but is not limited to: succession, competition, genetics, impact of human activity, and natural selection.

Sample Multiple-choice Questions for Chemistry

1. A scientist separates an element from rocks and finds that the element has atomic number 19.

   The element is expected to be

   A. a metal.

   B. a nonmetal.

   C. a halogen.

   D. a noble gas.

2. In comparing 1.00 mole of nitrogen monoxide gas (NO) and 1.00 mole of carbon dioxide gas (CO_2), each at 25°C and 1.00 atmosphere, which of the following is true?

   A. They have the same mass.

   B. They have the same number of atoms.

   C. They have the same volume.

   D. They have the same average molecular speed.

3. Which of the following is the best electron-dot diagram for hydrogen chloride (HCl)?

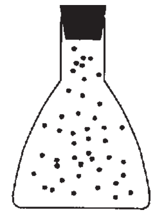
   A. $\mathrm{H}\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{Cl}}}$

   B. $\mathrm{H::Cl:}$

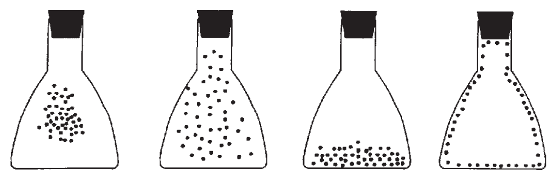
   C. $\mathrm{H:}\underset{\cdot\cdot}{\overset{\cdot\cdot}{\mathrm{Cl}}}\mathrm{:}$

   D. $\mathrm{HCl:}$

4. The following diagram represents a sealed flask filled with helium (He) gas at 20°C.
   (The dots represent the helium atoms.)



   Which diagram BEST illustrates the distribution of helium atoms in the flask when the temperature is lowered to –20 °C and helium remains a gas?



A. B. C. D.

5. Normal rainfall has a pH of about 5.5. A sample of acid rain has a pH of 4.5. When the H^+ ion concentration of normal rain and the acid rain sample are compared, acid rain has

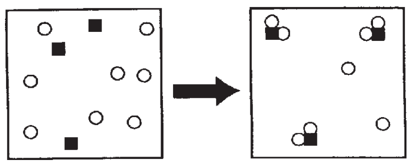
   A. less H^+ by a factor of 100.

   B. more H^+ by a factor of 100.

   C. less H^+ by a factor of 10.

   D. more H^+ by a factor of 10.

6. The reaction of element X (■) with element Y (o) is represented in the following diagram:



Which equation properly describes the reaction between X and Y?

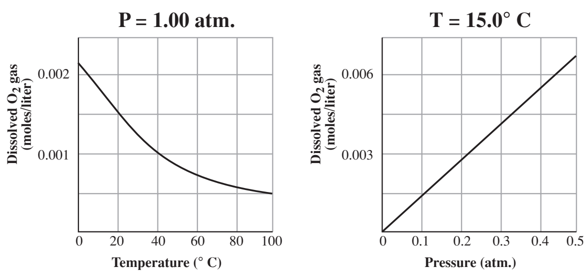
A. $3X + 8Y \longrightarrow X_3Y_8$

B. $3X + 6Y \longrightarrow X_3Y_6$

C. $X + 2Y \longrightarrow XY_2$

D. $3X + 8Y \longrightarrow 3XY_2 + 2Y$

Use the following diagram to answer questions 7 and 8.



7. The graphs above show the effect of temperature or pressure on the solubility of oxygen gas (O_2) in water. Dissolved oxygen is measured in moles/liter.

Which of the following changes in conditions would increase the solubility of oxygen gas?

A. Decrease temperature and decrease pressure.

B. Decrease temperature and increase pressure.

C. Increase temperature and decrease pressure.

D. Increase temperature and increase pressure.

8. What mass of oxygen gas (O_2) is dissolved in one liter of water at 40°C and a pressure of 1.00 atm? The molar mass of O_2 is 32.0 g/mole.

A. 0.0080

B. 0.016

C. 0.032

D. 0.064

Chemistry Answer Key

1. A	4. B	7. B
2. C	5. D	8. C
3. C	6. C	

Sample Laboratory Task for Chemistry

Title: Solubility of Ionic Compounds

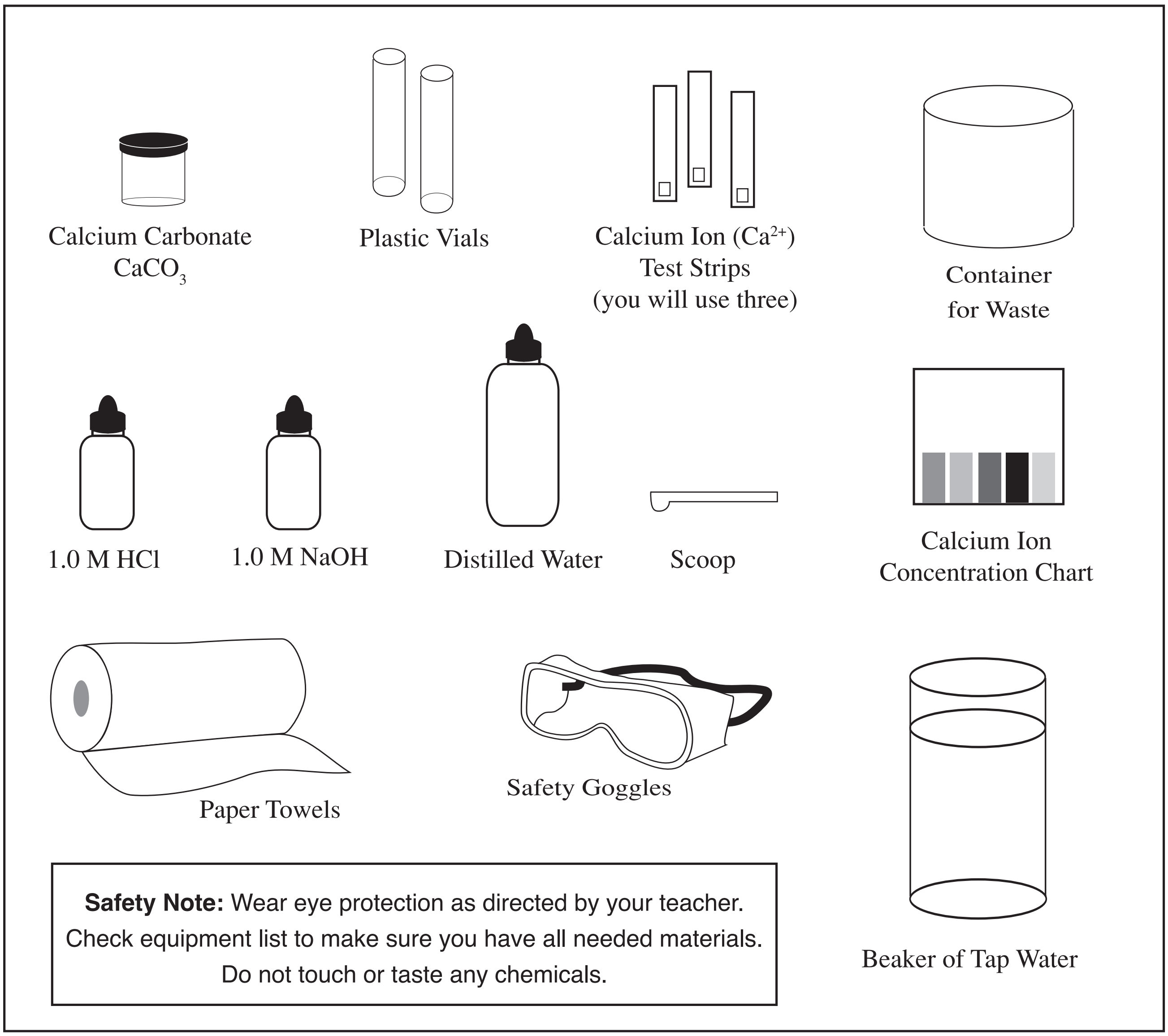
Investigation and Experimentation Standards – 1a,d,j,k,l

Chemical Bonds Standards – 2a,d; Acids and Bases Standards – 5a,b,c,d; Solutions Standards – 6a,b,d

Materials

On the table you will find each of the following:

Station Setup



Directions

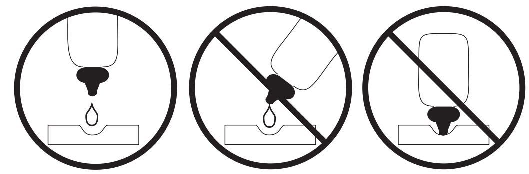
These instructions will not be repeated during the procedures.

Read and follow all the steps of this lab in the order given.

Record all observations, results, and answers to the questions as directed.

Immediately notify the proctor of spills or other problems.

When adding test solutions in the next sections, hold the bottles as illustrated in the diagrams.



Hold the bottles upright.
Do not contaminate stock solutions.

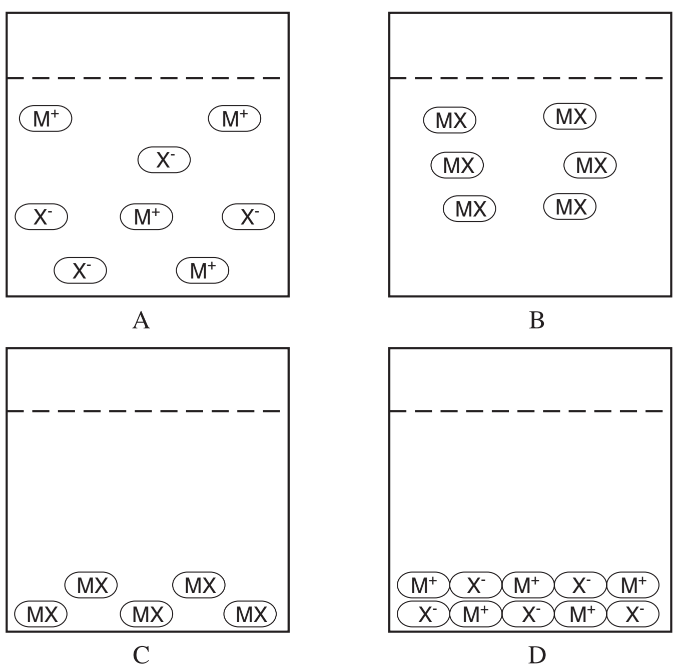
Statement of the Task

Solubility is a measure of the amount of a substance that dissolves in a given solvent. When ionic compounds dissolve in water, the ions released often affect the chemistry of the water, including its pH. The pH is a measure of the acid/base level. On the pH scale, 7 is neutral, below 7 is acidic, and above 7 is basic.

In this lab task, you will be determining the solubility of calcium carbonate, $CaCO_3$, an ionic compound which makes up sea shell and coral. You will then compare the effect of acids and bases on this solubility. Using the information gained, you will identify the cause of problems in a reef aquarium and propose a solution.

Solubility of Ionic Compounds

Use the following diagrams to answer questions 1 and 2.



1. Select the best representation of an ionic compound, MX, that is soluble (completely dissolves) in water. Explain your selection.

2. Select the best representation of an ionic compound, MX, that is insoluble in water. Explain your selection.

Solubility of Calcium Carbonate in Water

The solubility of ionic compounds varies widely: some dissolve completely, some dissolve partially, and some virtually not at all.

3. a. Place one scoop of calcium carbonate, $CaCO_3$, into one of the vials.
   b. Add distilled water to fill the vial halfway. **Do not stir**.
   c. Record your observations in Table 1 below.

4. Measure the calcium ion, Ca^{2+}, concentration in solution.
   a. Using one of the calcium ion test strips, dip the strip halfway into the calcium carbonate solution. See Figure 1.
   b. Immediately compare its color to the calcium ion concentration color chart provided.
   c. Record both the color and the concentration in Table 1 below.
   d. Save this vial and solution for later tests.

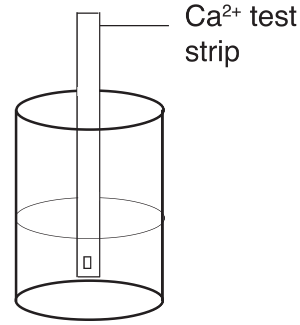


Figure 1

Table 1: Observations of Calcium Carbonate ($CaCO_3$) in Water

	observations	color of Ca^{2+} test strip	Ca^{2+} concentration
$CaCO_3$ added to distilled water			

5. Based on the data from Table 1, did the calcium carbonate completely dissolve, partially dissolve, or remain undissolved in the water? Use both your observations and the Ca^{2+} concentration to defend your choice.

Effect of Acid on Solubility of Calcium Carbonate

Acids can interact with the ions present in a solution, altering the solubility of ionic compounds.

6. a. Add 2 drops of 1.0 M HCl to the vial containing calcium carbonate in water. **Do not stir**.

   b. Observe any changes for a period of 30 seconds. Record your observations in the appropriate column in Table 2 below.

7. Repeat step 6 two more times, adding 2 more drops of 1.0 M HCl each time.

Table 2: Observations of Calcium Carbonate in an Acidic Solution

	After 2 drops HCl	After 2 more drops HCl (4 drops total)	After 2 more drops HCl (6 drops total)
observations			

8. a. Using a new calcium ion test strip, measure the calcium ion concentration after the 6 drops of HCl have been added.

   b. Immediately record the color and calcium ion concentration in Table 3 below.

Table 3: Calcium Ion Concentration in an Acidic Solution

color of Ca^{2+} test strip	Ca^{2+} concentration

9. a. What effect does adding an acid have on the solubility of calcium carbonate? Use both changes in appearance and changes in calcium ion concentration to justify your answer.

   b. Use the following equation to explain your observations of the $CaCO_3$ in water when the acid was added.

$$CO_3^{2-}(aq) + 2H^+(aq) \rightarrow H_2CO_3(aq) \rightarrow H_2O(l) + CO_2(g)$$

Effect of Base on Solubility of Calcium Carbonate

Bases can also interact with dissolved ions in a solution and alter the solubility of ionic compounds.

10. Prepare a second vial of calcium carbonate in water.

    a. Place one scoop of calcium carbonate, $CaCO_3$, into the second vial.

    b. Add distilled water to fill the vial halfway. **Do not stir.**

11. a. Add 2 drops of 1.0 M NaOH to the vial containing calcium carbonate. **Do not stir.**
    b. Observe any changes for a period of 30 seconds. Record your observations in the appropriate column in Table 4 below.
12. Repeat step 11 two more times, adding 2 more drops of NaOH each time.

Table 4: Observations of Calcium Carbonate in Basic Solution

	After 2 drops NaOH	After 2 more drops NaOH (4 drops total)	After 2 more drops NaOH (6 drops total)
observations			

13. a. Using a new calcium ion test strip, measure the calcium ion concentration after the 6 drops of NaOH have been added.
    b. Immediately record the color and calcium ion concentration in Table 5 below.

Table 5: Calcium Ion Concentration in Basic Solution

color of Ca^{2+} test strip	Ca^{2+} concentration

14. What effect does adding a base have on the solubility of calcium carbonate? Use both changes in appearance and changes in calcium ion concentration to justify your answer. You may include equations.

Application to the Reef Aquarium

Reef aquariums may contain saltwater fish and living coral. Corals are living organisms which require dissolved calcium ions to survive and form the reef. The level of calcium ions should be maintained at 400 – 450 mg/L for healthy coral.

The Problem:

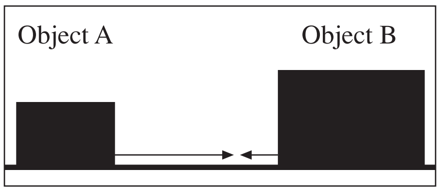
A reef aquarium owner is having trouble maintaining the proper calcium level. The owner keeps adding calcium carbonate, but the level of dissolved calcium ions remains between 280 – 300 mg/L. The measured pH is 8.5. In addition, a thin layer of white powder has settled to the bottom of the tank, and the water is cloudy.

15. Using knowledge about the solubility of $CaCO_3$ gained from this task and your knowledge of science, answer both of the following questions. Make your answers detailed and complete.

    a. Explain the settling of the white powder, the cloudiness, and the continued low levels of Ca^{2+} ions.

    b. Propose a solution. Explain how it would work to solve the problem of the low level of Ca^{2+} ions in the aquarium.

Sample Multiple-choice Questions for Physics

1. 

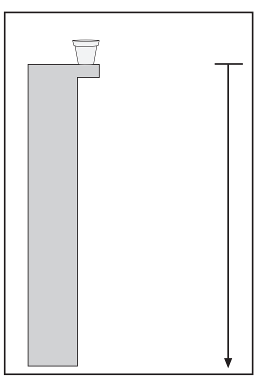
A 30-kg object (object A) sliding at 8 m/s across a frictionless surface collides head-on with a 60-kg object (object B) sliding at 2 m/s in the opposite direction. During the collision, the force of object A on object B

A. is one quarter the force of object B on object A.

B. is one half the force of object B on object A.

C. is equal to the force of object B on object A.

D. is twice the force of object B on object A.

2. 

A flower pot falls from a window ledge 5 meters above the sidewalk. Approximately how fast is the flower pot moving just before it hits the sidewalk?

A. 5 m/s

B. 10 m/s

C. 15 m/s

D. 50 m/s

3. A ball weighing 4 N is dropped off a high cliff. As it falls, it encounters 1 N of air resistance. The net force on the object is

A. 3 N upward.

B. 3 N downward.

C. 5 N upward.

D. 5 N downward.

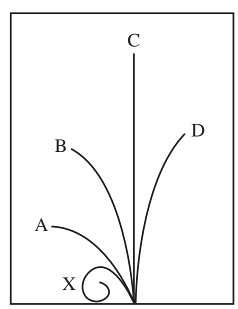
4. The increase in the kinetic energy of an object is equal to

A. the net impulse imparted to the object.

B. the increase in the velocity of the object.

C. the power expended divided by the elapsed time.

D. the net work done to increase the speed of the object.

5. 

Particles of the same speed are shot into a magnetic field perpendicular to the page in a detector that reveals their tracks as shown in the diagram above. If track X is made by an electron, which is the track left by a proton?

A. track A

B. track B

C. track C

D. track D

6. This test paper is sitting at rest on your desk. Which of the following statements best describes this situation?
   A. There are no forces acting on your paper.
   B. Your paper is at rest in any coordinate system.
   C. Your paper exerts no force on the desk.
   D. Several forces are acting on your paper, but they balance each other.

7. To double the current through a resistor in a circuit,
   A. double the voltage across the resistor.
   B. double the resistance of the resistor.
   C. double the voltage across the resistor and double the resistance.
   D. double the resistance and decrease the voltage across it by half.

8. The time that elapses between the arrival of a wave crest and the next wave crest is the
   A. amplitude.
   B. pulse width.
   C. frequency.
   D. period.

Physics Answer Key

1. C	4. D	7. A
2. B	5. D	8. D
3. B	6. D	

Sample Laboratory Task for Physics

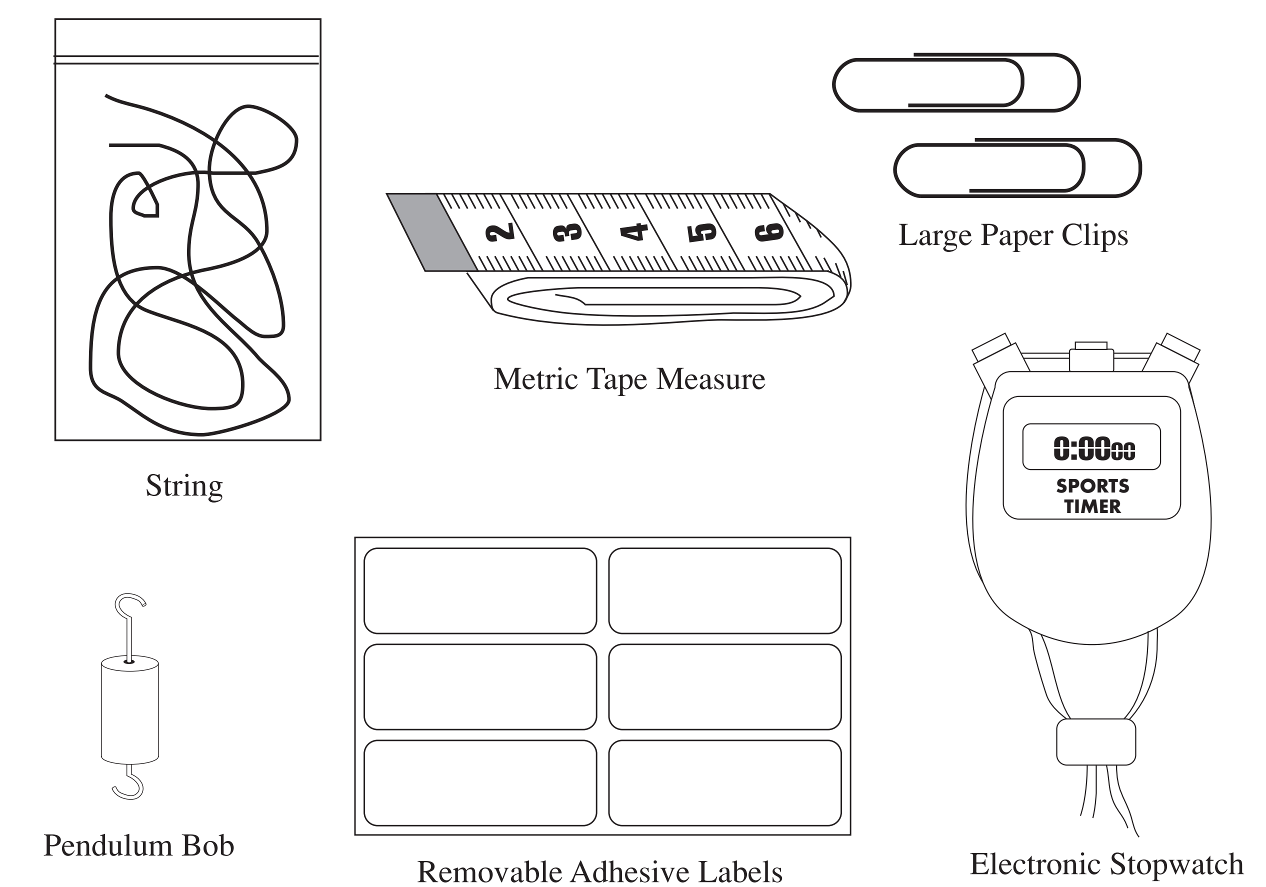
Title: The Simple Pendulum

Investigation and Experimentation Standards – 1a,b,c,d,j
Motion and Forces Standards – 1c,f,e
Conservation of Energy and Momentum Standards – 2b,c,f

Materials

On the table you will find each of the following:

Station Setup



Note:
Check equipment list to make sure you have all needed materials.

Directions

These instructions will not be repeated during the procedures.

Read and follow all the steps of this lab in the order given.

Record all observations, results, and answers to the questions as directed.

Immediately notify your instructor of missing equipment or other problems.

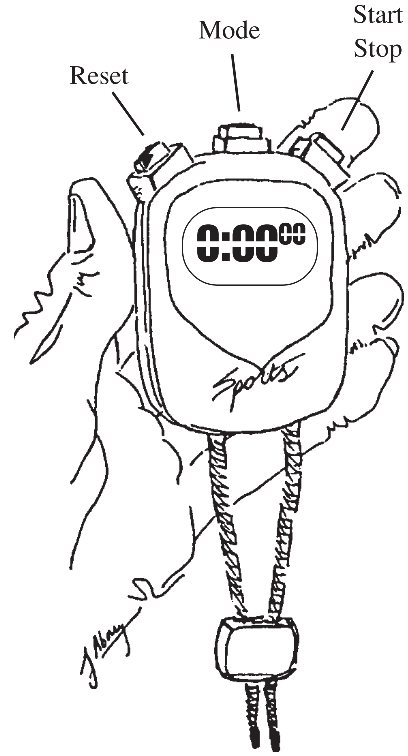
Statement of Task

Galileo conceived the pendulum clock while watching a swinging lamp put into motion by breezes in a drafty church. He timed it with his pulse and went home to investigate the variables that affect the time of the swings (period). The history of experimental physics almost begins with Galileo's analysis of a simple pendulum.

In this laboratory task, you will collect data to determine the periods of pendulums of different lengths, and you will construct a graph of period versus length. You will use your graph to predict the periods of two more pendulums of different lengths, then measure those periods and compare the results with your predictions. You will calculate the period of a pendulum in a location where g is not the acceleration of gravity at the surface of the Earth. Finally, you will discuss the effect of mass and the size of the arc on the period of a pendulum.

Using the Stopwatch

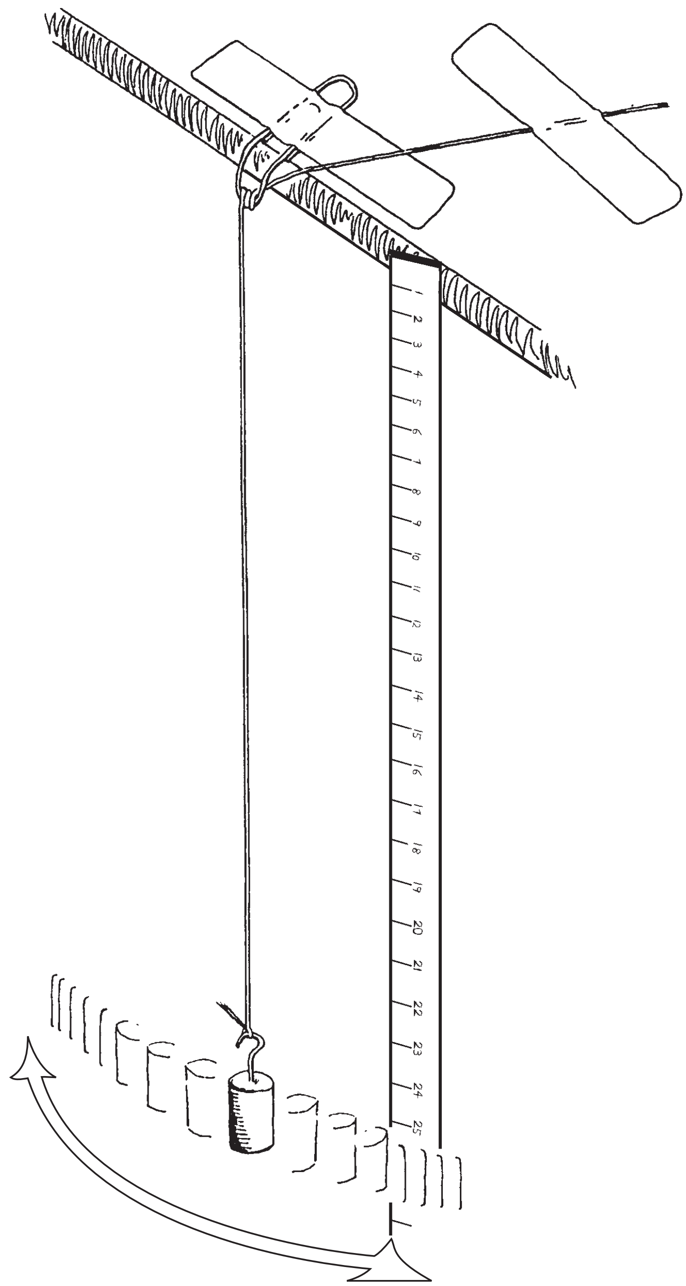
- The stopwatch has two modes: clock and timer. The mode is controlled by the center button. You know the watch is in the timer mode if arrows above Su, Fr, and Sa are blinking. If the watch is not in the timer mode, press the center button until the Su and Sa arrows are both blinking.
- The stopwatch timer measures to one hundredth of a second.
- In the timer mode, pressing the left button resets the watch to $0{:}00^{00}$. If pressing the left button once or more does not reset the timer, press the right button once. Now pressing the left button once or twice will reset the watch to $0{:}00^{00}$.
- With the watch at $0{:}00^{00}$, quickly press the right (Start/Stop) button once to begin timing and once to stop timing.
- To minimize reaction time error in using the stopwatch, it is recommended that you do a countdown to establish a cadence or beat. Get in sync with the swings of the pendulum, count silently to yourself, "5-4-3-2-1-0," when you begin and end any timing.



The Simple Pendulum

Apparatus Setup and General Procedures

1. Use one of the removable adhesive labels to secure the large paper clip to the edge of the table with the end hanging over the edge as shown in the illustration to the right. If the paper clip is not bent, bend the part that hangs over down a little. Your pendulum will hang from this. **Check frequently to see that the paper clip is unable to move.**
2. Tie one end of the string to the pendulum bob. Loop the loose end of the string around the end of the paper clip that is bent down, and secure the loose end of the string to the table with the second removable adhesive label. You will be changing the length of the pendulum by untaping this end of the string.
3. Make sure your pendulum can swing through a small arc without the weight or string being interfered with in any way. Do NOT use a large arc.
4. You will be timing how long it takes for 20 complete swings of the pendulum using four lengths of the string. Start the pendulum swinging and choose one endpoint of the arc to use for your timing. (Remember, the period, T, of a pendulum is the time for one complete swing from one endpoint over and back again to the same endpoint. It is recommended that you do your timings more than once at each length to develop confidence in your measurements.)
5. The length of the pendulum is the distance from the paper clip support to the CENTER of the weight. When measuring the pendulum, be sure to hold the tape measure tight so that you get an accurate measurement.
6. You will take data for the lengths listed in Data Table 1. Convert your data to fill in Data Table 2, and plot and analyze your results.



7. a. Fill in Data Table 1. Record the times for each trial in the table and enter your average. Remember that the length of the pendulum should be measured from the paper clip to the CENTER of the weight.

Data Table 1

	Time for 20 swings (s)		
Length of pendulum L (cm)	Trial 1	Trial 2	Average
30			
25			
20			
15			

b. Calculate the time for one complete swing (period) and enter it in Data Table 2 below. In the space at the right, give at least one example showing how you converted from "Time for 20 swings" to the period in seconds.

Data Table 2

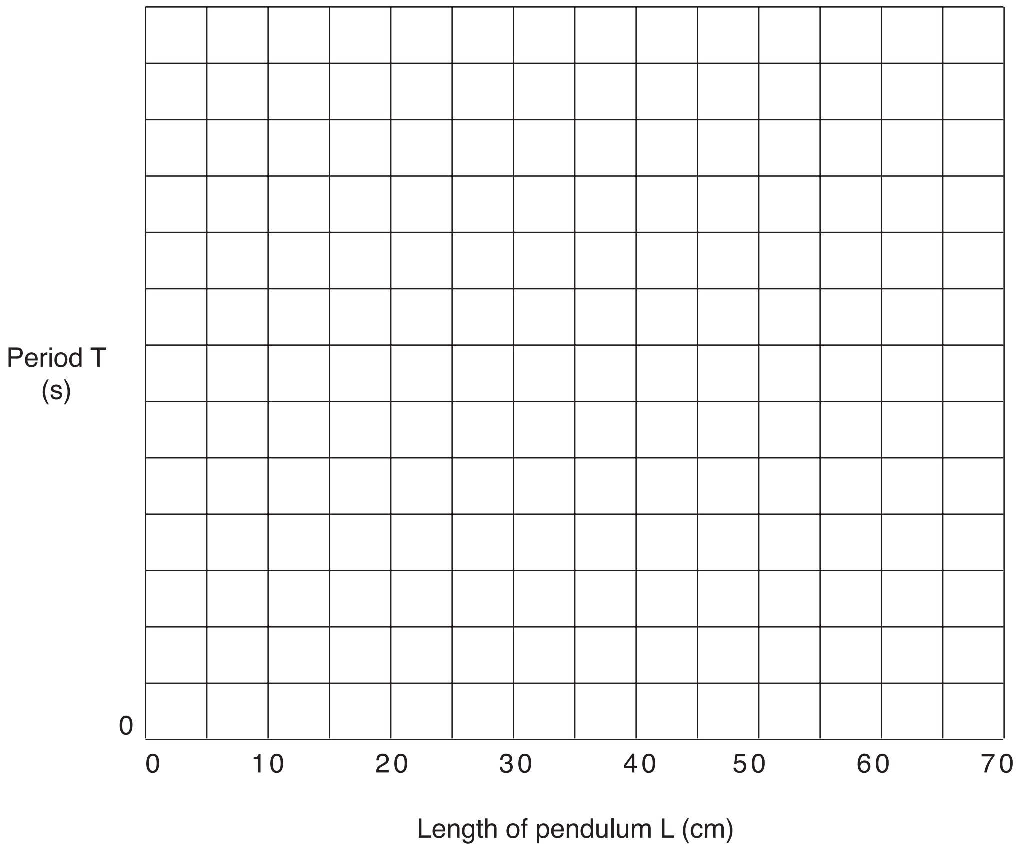
Length of pendulum, L (cm)	Time for ONE swing, Period, T (s)
30	
25	
20	
15	

Explain how you converted below:

Check to see if the values you have entered for the periods in Data Table 2 are consistent with what you saw happening as you changed pendulum lengths.

c. How does the period of a longer pendulum compare to the period of a shorter pendulum?

8. Using the axes, graph your data for the period T in seconds versus length L in centimeters. The horizontal axis is scaled for you. The extra length (up to L = 70 cm) will be used in a later part of the lab. Provide an appropriate scale for the period (vertical axis).



9. a. From your graph, predict the period of a pendulum of L = 60 cm. Mark this point with an X on your graph.

   Predicted Period for L = 60 cm: _______________ s

   b. Explain how you arrived at this value.

   c. Measure the period for L = 60 cm. Period = ________________ s

   Mark this point with a circled dot ⊙ on your graph.

   d. How well did your result agree with your prediction when L = 60 cm? Explain why your prediction agrees or disagrees.

Using the knowledge gained from this lab task and your own knowledge of science, answer questions 10 and 11. Make your answers detailed and complete.

10. Discuss why doubling the mass of a pendulum bob has NO effect on its period. Include in your discussion how weight depends on mass, Newton's law of inertia, and Newton's second law of motion (F = ma).

11. The size of the arc through which a pendulum swings DOES have an effect on the period. Do you think the time it takes a pendulum to complete one swing through a large arc (close to 90 degrees) should be longer or shorter than the time it takes to complete one swing through a small arc (about 10 degrees)?

    State your prediction and explain the reasoning behind your answer.

Physics Equation Sheet

MOTION AND FORCES

$v_{avg} = \frac{\Delta x}{\Delta t}$ $\quad v = v_0 + at$

$x = v_0 t + \frac{1}{2}at^2$ $\quad v^2 = v_0{}^2 + 2ax$

$SF = F_{net} = ma$ $\quad a_c = \frac{v^2}{r}$

$F_g = G\frac{m_1 m_2}{R^2}$ $\quad F_g = mg$

a = acceleration
a_c = centripetal acceleration
F = force
F_g = gravitational force or weight
g = gravitational acceleration
G = universal gravitational constant
m = mass
r = radius
v = speed
v_{avg} = average speed
v_0 = initial speed
t = time
x = distance
R = distance between m_1 and m_2

WAVES

$v = f\mathtt{l}$ $\quad n = \frac{c}{v}$

c = the speed of light
f = frequency
n = index of refraction
v = wave speed
$\mathtt{l}$ = wavelength

CONSERVATION OF MOMENTUM AND ENERGY

$W = Fd\cos\theta$ $\quad KE = \frac{1}{2}mv^2$

$PE = mgh$ $\quad P = \frac{W}{t}$

$p = mv$ $\quad Dp = mDv = Ft$

$m_1 v_1 + m_2 v_2 = m_1 v_1{}' + m_2 v_2{}'$

d = distance
F = force
KE = kinetic energy
m = mass
p = momentum
P = power
PE = potential energy
W = work
t = time
v = speed
θ = angle

ELECTRIC AND MAGNETIC PHENOMENA

$E = \frac{F}{q}$ $\quad V = IR$

$P = IV$ $\quad P = I^2R$

E = electric field
F = force
I = current
P = power
q = charge
R = resistance
V = potential difference or voltage

HEAT AND THERMODYNAMICS

$Q = mcDT$ $\quad Q = mL$

$W = PDV$ $\quad Q = DU + W$

c = specific heat capacity
L = latent heat
m = mass
P = pressure
Q = heat
T = temperature
U = internal energy
V = volume
W = work

PHYSICAL CONSTANTS

Gravitational acceleration on Earth:
$g = 9.8$ m/s^2

Universal gravitational constant:
$G = 6.67 \times 10^{-11}$ N·m^2/kg^2

Proton mass and neutron mass:
$m = 1.67 \times 10^{-27}$ kg

Electron mass:
$m = 9.11 \times 10^{-31}$ kg

Elementary charge:
$e = 1.6 \times 10^{-19}$ C

Speed of light:
$c = 3.0 \times 10^8$ m/s

Sample Multiple-choice Questions for Second-year Integrated/Coordinated Science

1. A student is experimenting with a potato and salt solution. A fresh slice of potato weighs 3.5 grams. The slice is then placed in a beaker containing 60% salt solution. After 15 minutes the slice is removed and weighed again. What is the most likely result?

   A. 3.0 g

   B. 3.5 g

   C. 4.0 g

   D. 7.0 g

2. Autotroph is the name given to a plant which can capture light energy and convert it to a more usable form. It is able to do this because it has

   A. bright-colored flowers which absorb and use the light energy.

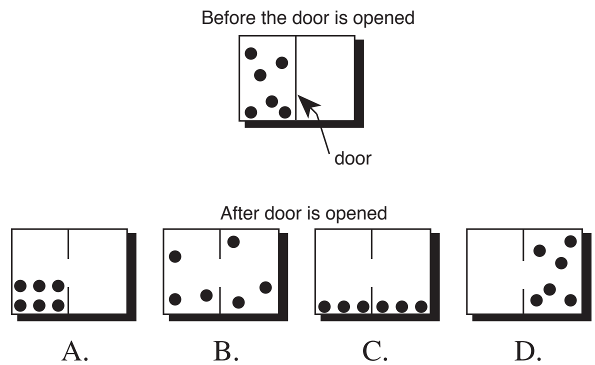
   B. roots which take up more water as the plant obtains more energy.

   C. chlorophyll which converts the energy through chemical reactions.

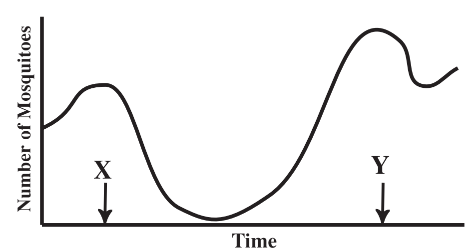
   D. the ability to turn from the sunlight to keep cool.

3. The dots in the diagrams below represent gas molecules trapped in a box.

   What is the MOST likely arrangement of gas molecules in the box after the door separating the two sides is opened?



4. **Effects of Pesticides on Mosquito Populations**



   A pesticide was sprayed at time X and again at time Y. Many of the mosquitoes were killed after the first spraying.

   Which of the statements below BEST explains the shape of the graph above?

   A. Offspring of the survivors are weakened and killed by the second spraying of the pesticide.

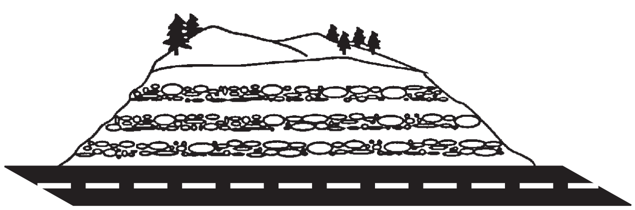
   B. Offspring of the survivors are unable to reproduce.

   C. Offspring of the survivors are better able to survive the pesticide.

   D. The survivors are unable to reproduce offspring.

5. Sugar is stirred into warm coffee until no more sugar will dissolve and a saturated solution is formed. What can you do to get more sugar to dissolve into the coffee?
   A. Add a more finely ground sugar.
   B. Heat the coffee to a higher temperature.
   C. Stir the coffee for a longer time.
   D. Pour out some of the coffee.

6. A road is cut through a hill. The diagram below represents the cut hillside on the side of the road. It shows layers of rounded boulders separated by layers of hardened dirt.



   This site was probably a former
   A. fault zone.
   B. ocean floor.
   C. volcanic magma chamber.
   D. river bed.

7. A car has just been driven for several miles and comes to stop. The car manual says the tire pressure should be 32 pounds per square inch. The driver checks the tire pressure and finds the pressure is
   A. higher because the tire is warm.
   B. higher because the tire is cold.
   C. lower because the tire is warm.
   D. lower because the tire is cold.

Second-year Coordinated Science Answer Key

1. A	4. C	7. A
2. C	5. B	
3. B	6. D	

Sample Laboratory Task for Second-year Integrated/Coordinated Science

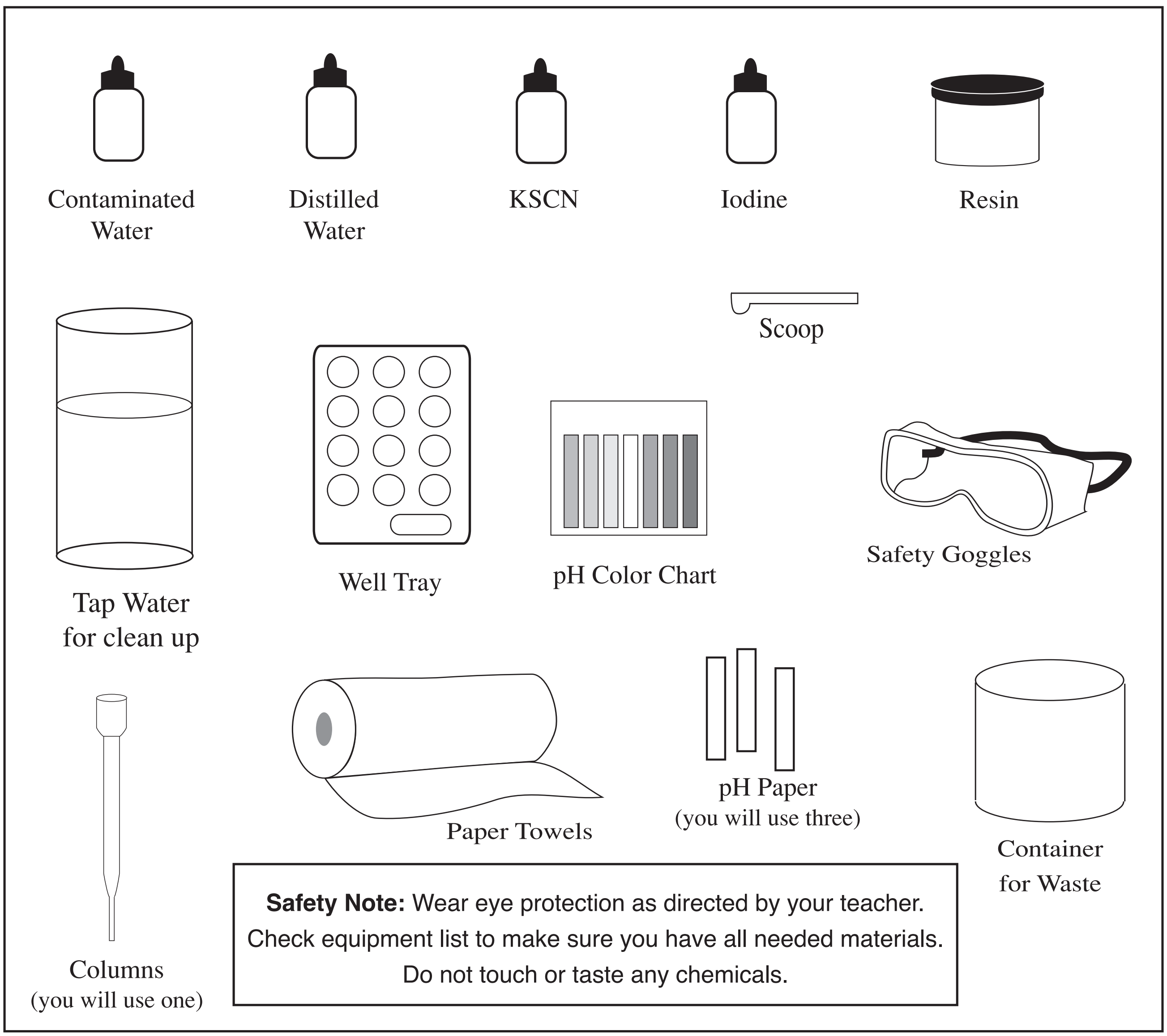
Title: Water Clean Up

Investigation and Experimentation Standards – 1a,d,k,l,m
Chemistry, Acids and Bases Standards – 5a,b; Solutions Standard – 6a
Biology/Life Sciences, Ecology Standards – 6b,d

Materials

On the table you will find each of the following:

Station Setup



Safety Note: Wear eye protection as directed by your teacher. Check equipment list to make sure you have all needed materials. Do not touch or taste any chemicals.

Directions

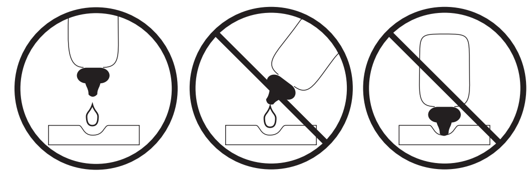
These instructions will not be repeated during the procedures.

Read and follow all the steps of this lab in the order given.

Record all observations, results, and answers to the questions as directed.

Immediately notify the proctor of spills or other problems.

When adding test solutions in the next sections, hold the bottles as illustrated in the diagrams.



Hold the bottles upright.
Do not contaminate stock solutions.

Statement of the Task

Water is necessary for all living systems. Water is such a good solvent that removing dissolved substances and obtaining very pure water is quite difficult. Water may dissolve substances necessary for living systems as well as those that are potentially harmful or undesirable.

In this lab task, you will investigate how to remove potentially harmful substances from solutions by using simulated substances for safety. Typically, these substances can include hydrocarbons, metals, acids/bases, and coloring agents. Household, government, and commercial water purification facilities use methods similar to those you will investigate, except on a large scale.

To accomplish this task you will:

- test a known sample of contaminated water (non-harmful) for four possible contaminants.
- investigate which substances can be removed by different absorber materials (sand, charcoal, or synthetic resin).
- design an absorber column to remove the contaminants.

This task uses the following substances as simulated contaminants:

- Starch represents hydrocarbons.
- Iron represents heavy metals.
- Acid/base conditions represent acidity or basicity.
- Iron and/or food color represents evidence of visible contaminants (or colored impurities).

The chemicals used in this lab task are very safe, very dilute, and commonly used in science classrooms.

Part 1. Testing for Substances in Water

Perform the following procedures to test for contaminants in a known water sample.

a. Put two drops of contaminated water sample (containing starch, iron, coloring agents, and acids/bases) into a clean well in the well tray.

   NOTE: Shake contaminated water before using.

b. Observe and record color observation in Table 1, including the color of dry pH paper.

c. Repeat steps a and b for the following samples. Use a clean well for each sample.

   - distilled water
   - iodine solution
   - KSCN solution

d. Clean your well tray with tap water and a paper towel.

e. Using **Figure 1** as a guide, put two drops of the distilled water sample into each of three **unused** wells of the well tray for control testing of each contaminant. Each well will be used for a separate test.

f. Test the distilled water sample for the three contaminants by doing steps **g** through **i**. Record observations carefully in Table 2.

g. Add 1 or 2 drops of iodine solution to the first well and record results. If you get a **green-black color or blackish solid, starch is present.**

h. Add 1 or 2 drops of KSCN solution to the second well. If you get a **pinkish to blood-red color, iron is present.**

i. Dip a piece of pH paper into the third well. Record color. Using the pH chart, determine and record the pH. **Save the pH paper for comparison in Part 2.**

j. Put two drops of contaminated water into each of three different, unused wells.
NOTE: Shake contaminated water before using.

k. Repeat steps **g** through **i** using the contaminated water and record results in Table 2.

l. Do not clean the well tray. You will refer to it in Part 2 of this task.

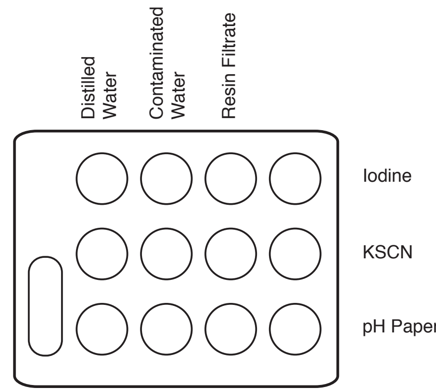


Figure 1

Table 1: Observations before Testing

Substance	Contaminated water	Distilled water	Iodine	KSCN	pH paper
Color observed					

Table 2: Observations after Testing

Record observed color

Sample	Iodine test for starch	KSCN test for iron	pH paper test for acid/base
Distilled water			
Contaminated water			

1. Do your observations for the distilled water testing match your observations in Table 1? Why or why not?

2. In Table 3, summarize your results by telling which contaminants are **present or missing** from the contaminated water and the distilled water. You will use this information again in step 3.

Table 3: Conclusions

Record "present" or "missing"

Sample	Starch	Iron	Acid/Base
Distilled water			
Contaminated water			

Part 2. Water Purification Tests

3. You are now ready to test how absorbers (sand, charcoal, and resin) might work to purify a contaminated water sample.

   Sand and charcoal have been tested as absorbers for you. The observations and conclusions are recorded in Table 4 and Table 5. Follow the procedure below to test resin as an absorber. Record your observations of color changes in Table 4 and conclusions in Table 5.

   NOTE: Shake contaminated water before using.

   Absorbers are best tested using a column device. Find a clean column from your kit.

   a. Using the scoop, fill the column with resin up to the first mark as shown in Figure 2. You may need 10 to 15 scoops. Tap the sides of the column so the resin falls to the bottom as much as possible. Do not be concerned if some resin remains on the sides or falls out.

   b. Slowly add about 20 drops of contaminated water onto the absorber. Do NOT fill up the column with the contaminated water. Drops should begin to drip out of the bottom. Allow the first 7 drops to fall into the larger well in your tray. This is waste.

   c. Collect two drops of filtrate into each of **three** clean wells in your well tray as shown in Figure 1. You may need to add a **few** more drops of contaminated water to the top of the column.

   d. Discard the used column in your waste container.

   e. Test the filtrate in the 3 wells for contaminants using steps **g** through **i** on page 39. Record your observations in Table 4.

   f. Compare your observations in Table 4 to those in Tables 1, 2, and 3 to determine which contaminants are still present, removed, or partially removed, and record your conclusions in Table 5.

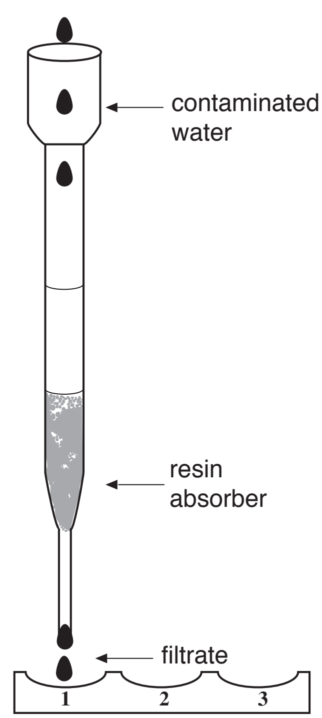


Figure 2

Table 4: Observations

Record observed color		Filtrate after testing		
Absorber	Filtrate Color	Iodine test for Starch	KSCN test for Iron	pH paper test for Acid/Base
Sand	*Paler green*	*Green black*	*Pinkish red*	*Orange-pink* *pH = 3*
Charcoal	*Clear*	*Pale yellow* *(no starch)*	*Pinkish red*	*Orange* *pH = 4*
Resin				

Table 5: Conclusions: Contaminants in Filtrate after Testing

Absorber	Present Before Filtering	After Filtering		
		Present	Removed	Partially Removed
Sand	Starch Iron Food Coloring Weak Acid	*Starch* *Iron* *Weak Acid*	*None*	*Food Coloring*
Charcoal	Starch Iron Food Coloring Weak Acid	*Iron*	*Starch* *Food Coloring*	*Weak Acid*
Resin	Starch Iron Food Coloring Weak Acid			

Purification of Unknown Water Sample

4. Using contaminated water and absorber materials similar to those used in this task, design and describe a procedure that would enable you to purify the contaminated water in one continuous process. Explain how you would know the contaminants were actually removed.

5. What other contaminants, in addition to those tested in the task, might be in water and have to be removed to produce drinking water?

6. Does water have to be pure to be safe to drink? Explain why or why not.

Using the knowledge gained from this lab task and your own knowledge of science, answer the question below. Make your answer detailed and complete.

7. After a natural disaster such as an earthquake or a flood, emergency broadcasters announce that all water should be boiled before drinking. Given a sample of water contaminated by this disaster, do you believe boiling the sample would be sufficient to purify it? Use information from this lab task and your knowledge of science to explain your answer. (Consider all possible sources of contamination.)

This page may be included in each test booklet for the student to use as a reference.

Periodic Table of the Elements

1 H 1.008																	2 He 4.003
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (97)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.33	57 *La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.21	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.03	89 **Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)									

*Lanthanide Series

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (147)	62 Sm 150.4	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97

**Actinide Series

90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (254)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

Units, Definitions, and Abbreviations

L = liter
mL = milliliter
1 L = 1000 mL

m = meter
cm = centimeter
mm = millimeter
nm = nanometer
Å = Angstrom
1 m = 100 cm = 1000 mm = 10^9 nm = 10^{10} Å

g = gram
kg = kilogram
1 kg = 1000 g

s = second

mol = mole
M = molar = moles per liter

°C = degrees Celsius
K = degrees Kelvin

kPa = kilopascal
atm = atmosphere
mm Hg = millimeters of mercury

J = joule
kJ = kilojoule
4.18 J = 1 calorie (cal)

E° = reduction potential
V = volt

STP = Standard Temperature and Pressure
standard temperature = 0°C = 273 K
standard pressure = 760 mm Hg = 1 atm = 101.3 kPa

PV = nRT
n = number of moles of gas
R = gas constant
= 0.0821 L • atm/mol • K
= 8.31 J/mol • K